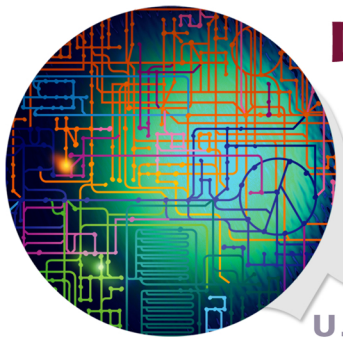


DOE GENOMICS:GTL

SYSTEMS BIOLOGY FOR ENERGY AND ENVIRONMENT

OFFICE OF SCIENCE
U.S. DEPARTMENT OF ENERGY

This document

has been updated.

New file is available at

http://doegenomestolife.org/pubs.shtml

November 2005

GENOMES to LIFE
BIOLOGICAL SOLUTIONS FOR ENERGY CHALLENGES
INNOVATIVE APPROACHES ALONG UNCONVENTIONAL PATHS

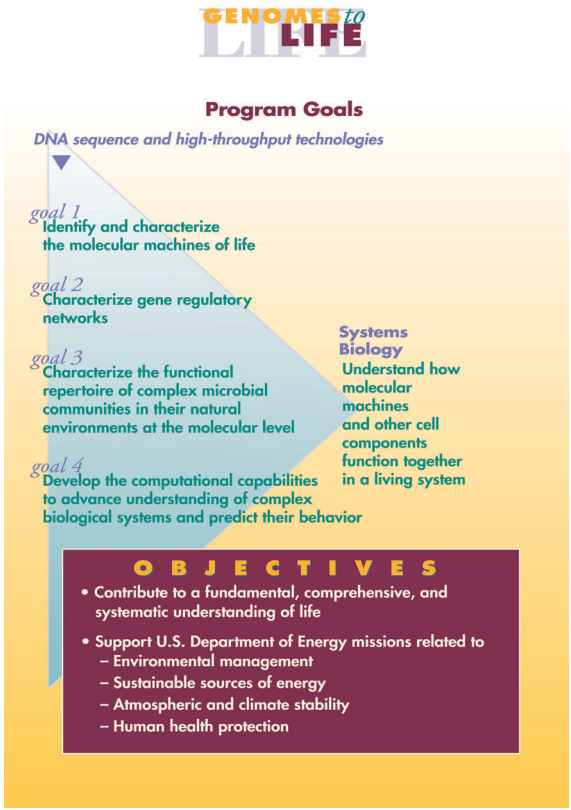
Program Overview

The revolution in biology triggered by the Human Genome Project now promises far-reaching benefits to our nation and our environment. Today, scientists have in hand the complete DNA sequences of genomes for many organisms—from microbes to plants to humans. For the first time, we can begin to explore the "operating systems" of life written into these genetic codes and put them to use. At the leading edge of this great scientific frontier is the Genomes to Life program, whose overarching goal is to use these tools to target critical DOE mission challenges in energy security, global climate change, toxic waste cleanup, and health protection.

Innovative Solutions Along Unconventional Paths

The Genomes to Life roadmap (April 2001) sets forth an aggressive plan designed to exploit new high-throughput genome-based strategies to obtain fundamental knowledge of how living systems function (see chart at right). Potential benefits of this program are enormous. Perhaps the most important mission-related applications are

- Clean, biology-based energy to enhance energy security
- Reduced carbon dioxide in the atmosphere to help stabilize global climate
- Dramatic savings and more effective environmental cleanup



A "Systems-Level" View

The Genomes to Life program reflects the fundamental change now occurring in the way biologists think about biology. The new program builds on the successes of the growing number of genome research projects by exploiting the data and extending the new paradigm of comprehensive, whole-genome biology to the next level. This systems biology approach, which explores complex interactions of many levels of biological information simultaneously, ultimately will enable an integrated and predictive understanding of how cells behave and respond to environmental changes. Applications of this level of understanding may well result in novel biological solutions to some of our most challenging national needs.

Technology and Computing Needs for Systems Biology

Current state-of-the-art instrumentation and computation enable and encourage the establishment of this ambitious and far-reaching program. However, concurrent technology development is needed to reach all goals within the next decade. Substantial efforts will be devoted, for example, to improving technologies for characterizing proteins and protein complexes, localizing them in cells and tissues, carrying out high-throughput functional assays of complete cellular protein inventories, and sequencing and analyzing microbial DNA taken from natural environments.

Further, the wealth of data to be collected in studies of dynamic living systems will have meaning only if it can be assimilated, understood, and modeled on the scale and complexity of real living systems and processes, a task requiring advanced computational methods and capabilities. To meet these grand challenges of the new biology, the offices of Biological and Environmental Research and Advanced Scientific Computing Research within the DOE Office of Science have formed a strategic alliance to lay the foundation for a large computational and mathematical infrastructure. These advances will complement experimental and theoretical biology to build a larger, intellectually richer and more agile biology enterprise. These synergies are critical for making biological knowledge widely available and stimulating new biological discovery and understanding.

DOE Office of Science: Continuing a Tradition of Achievements

In 1986 the DOE Office of Science launched the Human Genome Project to understand, at the DNA level, the effects of energy production on human health. The benefits from this project far exceeded this original goal. Today, DOE is poised to take the next vital steps—translating the genetic code in DNA into a new understanding of how life works and applying those biological processes to serve its challenging missions. DOE has the historic perspective, track record, and infrastructure to conduct the large-scale, complex, mission-driven science needed to achieve these goals.

Extraordinary Tools for Revolutionary Science

The DOE Office of Science is strongly positioned to make major contributions to the scientific advances promised by the biology of the 21st century. Strengths of DOE's national laboratories include major facilities for DNA sequencing and molecular structure characterization, high-performance computing resources, the expertise and infrastructure for technology development, and a legacy of productive multidisciplinary research essential for such an ambitious and complex program. In the effort to understand biological systems, these assets and the Genomes to Life program will complement and extend the capabilities and efforts of the National Institutes of Health, the National Science Foundation, and other agencies and institutions around the world.

GTL Genesis

GTL was developed in response to a 1999 charge by the DOE Office of Science to the BER advisory committee to define DOE's potential roles in post-HGP science. The resulting report, *Bringing the Genome to Life* (August 2000), set forth recommendations that led to the *Genomes to Life* roadmap (April 2001). The FY 2002 budget for the program is $19.5 million.

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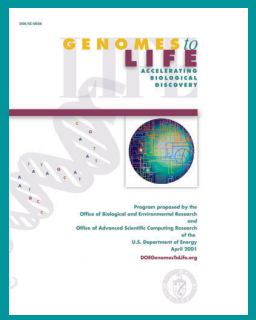


Copies of the April 2001 roadmap, along with associated documents, meeting reports, and image gallery, are downloadable via the Web:

- **DOEGenomesToLife.org**

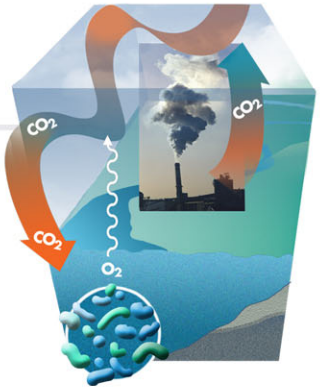
Future materials published about GTL may be requested from:

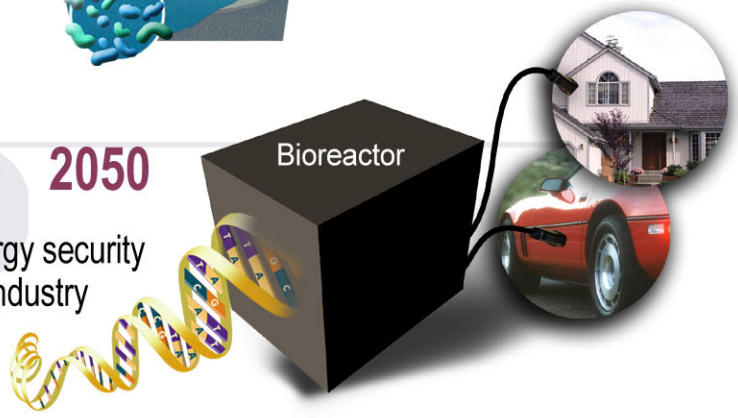
- **Human Genome Management Information System**
  865/576-6669, Fax: /574-9888
  mansfieldbk@ornl.gov

Payoffs for the Nation

GENOMES to LIFE
BIOLOGICAL SOLUTIONS FOR ENERGY CHALLENGES
U.S. DEPARTMENT OF ENERGY
INNOVATIVE APPROACHES ALONG UNCONVENTIONAL PATHS

Within a Decade	*Long Term*
Develop knowledge base for cost-effective cleanup strategies	**2020** Save billions of dollars in toxic waste cleanup and disposal
Understand earth's natural carbon cycle and design strategies for enhanced carbon capture	**2040** Help stabilize atmospheric carbon dioxide to counter global warming
Increase biological sources of fuels and electricity	**2050** Contribute to U.S. energy security • Biohydrogen-based industry in place





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